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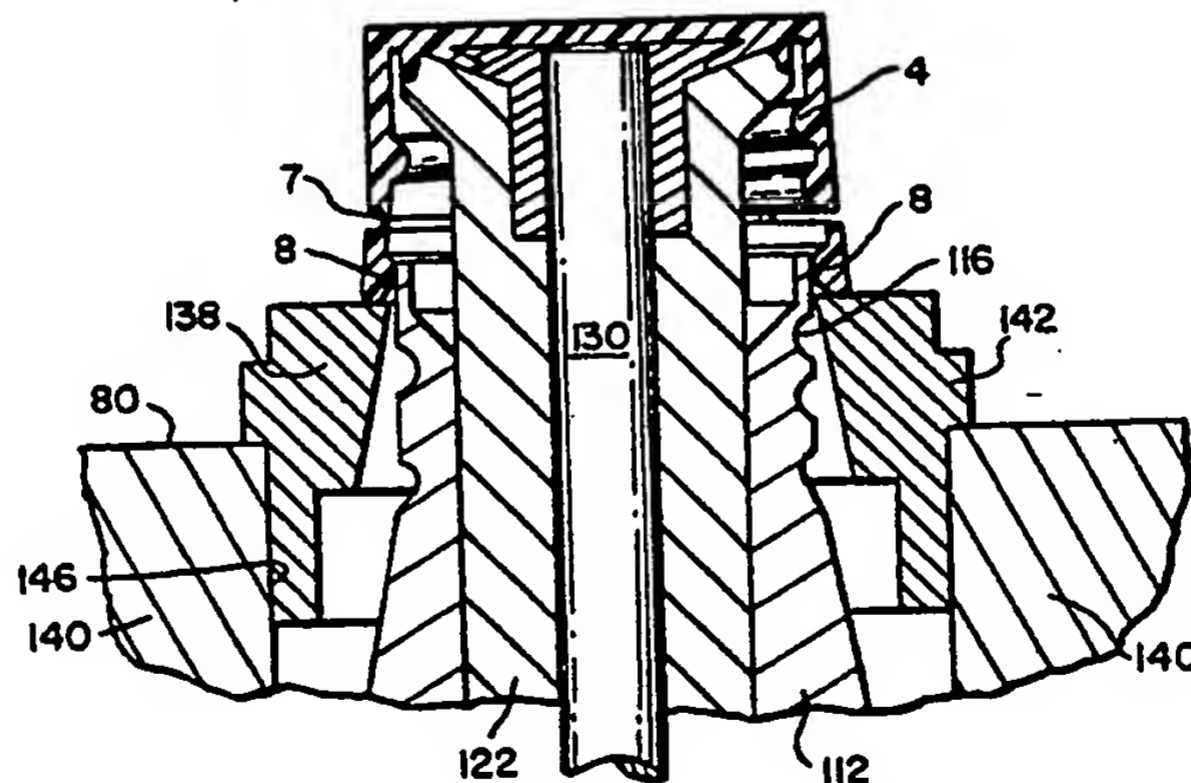
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(57) Abstract

A molded plastic pilfer-proof cap having frangible members (7) connecting the pilfer-proof ring (3) to the skirt (2) of the cap and in axial alignment therewith and having sufficient strength to permit flexing under axial compression but to break when flexed while under tension. The mold (50) for forming the cap includes inner male (54) and outer female members (52) for forming the mold therebetween. The female member includes radially movable cams (74) for engaging the male member to define the mold space for forming the frangible members of the cap.

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PILFER-PROOF CAP AND METHOD
AND APPARATUS FOR MAKING SAME

BACKGROUND OF THE INVENTION

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The present invention relates to an improved cap for use with containers whereby removal of the cap leaves behind a telltale ring member. This invention also relates to a method and mold for forming the caps and to a method of removing them from the mold. There are presently available many pilfer-proof closure or cap constructions of this type. Tamper evident container caps are widely used to demonstrate to the final consumer that the contents of a container have not been contaminated or adulterated subsequent to the time the cap was initially secured to the container.

Generally, pilfer-proof caps are constructed with a threaded skirt portion extending downwardly from the top wall of the cap and a pilfer-proof ring member attached to the lower end of the skirt. The ring is attached by frangible members which break upon unthreading of the cap from the container due to engagement of the ring member below a protruding ledge or shoulder on the container. More particularly, the ring includes an inside annular rib which, in use on the container, is located below a cooperating outwardly extending rib on the neck of the container. As the cap is twisted off the container, contact between the outside rib on the container neck and the inside rib on the separable ring of the cap breaks the previously mentioned frangible members, separating the ring from the remainder of the cap.

With metal closures, the formation of the pilfer-proof ring is typically effected after the closure has been placed onto the container. More particularly, the pilfer-proof ring is secured under a cooperating shoulder on the container neck by a rolling operation. With the advent of molded plastic caps, the pilfer-proof ring portion of the cap

is preformed as part of the initial molding of the cap. This presents some problems with respect to structuring the pilfer-proof ring and frangible members so that the cap can be threaded onto the container without breaking the frangible members. If breakage occurs, the ring is obviously of no value for use as an indicator of tampering with or removal of the closure.

The molding of plastic caps with pilfer-proof rings also presents some problems. The molding operation requires an internal die member for shaping the internal surface of the cap. This die member has external threads just like the bottle with which the cap is to be used. This thread structure and other portions of the die required for forming the pilfer-proof ring can interfere with removal of the cap by obstructing the ring and causing it to break away just as if the cap were being unthreaded from the container.

Attempts have been made to design plastic caps to overcome the problems associated with molding and applying the cap to the container. My prior patent, No. 4,322,012 discloses a molded plastic pilfer-proof cap in which the pilfer-proof ring is attached to the skirt by frangible members and constructed internally with locking members having the appropriate camming surface to permit threading of the cap to the container without breaking of the frangible members. Molding of this type of cap construction, however, typically requires a collapsible inner die member.

U.S. Patent No. 4,147,268 also discloses a molded plastic pilfer-proof cap. In this cap the pilfer-proof ring is constructed with internally protruding locking members which extend at an angle so as to permit the cap to be removed from the internal die member by unthreading. This same structure permits the cap to be threaded onto the container. In addition, the locking members are provided with camming surfaces to permit sliding over the locking

shoulder of the container as the cap is fully threaded onto the container.

SUMMARY OF THE INVENTION

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The pilfer-proof cap constructed in accordance with the teachings of the present invention includes a pilfer-proof ring which is structured and connected to the skirt portion of the cap in such a manner as to readily permit its removal from the internal molding die and subsequent attachment to the container. More particularly, the pilfer-proof ring is constructed with an inwardly protruding locking means, in the form of an annular rib, for engagement under a cooperating rib or shoulder on the neck of the container to which it is applied. The frangible means which connects the pilfer-proof ring to the lower end of the skirt portion of the cap is axially aligned with both the skirt and the pilfer-proof ring.

The mold for forming this cap comprises a female member forming a socket and an orifice for conducting plastic material into the socket, and a male member including a core assembly axially extending into the socket to form a mold cavity with the female member. The outer surface of the male member has a first annular recess for forming the radially inwardly extending rib on the tamper indicating ring and a second threaded recess for forming the internal threads on the cap. The female member of the mold includes an upper assembly that forms an upper portion of the socket, and a lower assembly having a plurality of cams that form a lower portion of the socket. Each of these cams has a radial protrusion engaging the core assembly of the male member at circumferentially spaced intervals to form an annular recess in the cap axially separating the skirt portion from the ring and circumferentially separating the frangible members which connect the ring to the skirt.

To remove the cap from the mold, the female member of the mold is removed from the cap, and then the cap itself is removed from the male member of the mold. The female member is removed from the cap by moving the upper assembly
5 of the female member axially and the cams thereof radially away from the cap. Preferably, the cap is shrunk onto the male member to develop a space between the cap and the female member of the mold prior to removing the female member from the cap. Developing this space between the cap and the
10 female member of the mold eliminates any tendency of the female member to rub against the cap or to tear or to pull the cap apart as that female member is removed from the cap. This permits the molding of caps wherein the outer wall surface of the skirt portion is at a right angle to the top
15 of the cap rather than tapered outwardly from that top.

Removal of the cap from the male member is accomplished, in part, by pushing on the bottom edge of the ring of the cap in an upward direction. This forces the inside rib of the ring out of the annular recess of the male
20 member in which that rib is formed.

The cap may be removed from the mold without exerting tensile forces on the frangible members of the cap. The axial alignment of the frangible members with the skirt and ring together with their thickness provide enough axial
25 rigidity to prevent the pilfer-proof ring from unduly flexing relative to the skirt portion of the cap during this removal operation. The entire wall structure of the cap simply expands more or less as an integral unit. Thus, breaking of the frangible members is avoided. In this way, the frangible
30 members may be designed to break readily when any appreciable tensile force is applied to those members, insuring that the tamper indicating ring of the cap will break away from the skirt of that cap when the cap is removed from a container.

This same feature is also useful during attaching
35 the cap to the container. As the cap is threaded down onto

the neck of the container,⁵ the bottom of the pilfer-proof ring engages against the threads and creates an axial compression of the ring toward the overlying skirt. This holds the ring, frangible members and skirt together in
5 compression as an integral unit and permits them to expand without such severe flexing of the ring relative to the skirt which would cause breaking of the frangible members. The bottom surface of the protruding rib locking means on the pilfer-proof ring is also structured to readily permit this
10 expansion of the ring over the threaded portion of the neck of the container.

BRIEF DESCRIPTION OF THE DRAWINGS

15 Fig. 1 is an enlarged cross-section view of the cap of the present invention showing generally in schematic form a part of the internal mold structure on which it is molded and with the cap partially removed therefrom; and

20 Fig. 2 is an enlarged cross-sectional view, partly broken away, showing the cap of the present invention as attached to a container.

Fig. 3 is an enlarged front view of a cap having internal top sealing members formed in a mold constructed in accordance with this invention.

25 Fig. 4 is an axial cross-sectional view of the cap shown in Fig. 3, taken along line 4-4 thereof, showing the cap secured to a container.

30 Fig. 5 is a front cross-sectional view through the mold used to form the cap shown in Figs. 3 and 4, showing the mold in a closed position.

Fig. 6 is a side cross-sectional view through the mold shown in Fig. 5, showing the mold in an open position.

Fig. 7 is a top view showing the cams of the female member of the mold illustrated in Figs. 5 and 6.

Fig. 8 is an enlarged view of a portion of Fig. 5 showing the mold cavity in which the cap is formed and the immediately adjacent parts of the mold in greater detail.

5 Figs. 9 and 10 are similar to Fig. 8 and depict in sequential order different stages of the removal of the cap from the mold.

Fig. 11 is a simplified view of a molding apparatus carrying a plurality of molds of the type shown in Figs. 5 and 6.

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DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to Figs 1 and 2 the cap of the present invention generally includes a top wall 1, a
15 depending side wall or skirt 2 and the improved pilfer-proof ring 3 attached to the bottom end of the skirt. The internal wall surface of the skirt includes a threaded portion 4 adapted to mate with complementary threads 5 on the neck 6 of a container such as shown in Fig. 2. The cap is fabricated
20 from a relatively rigid plastic such as polypropylene.

The pilfer-proof ring 3 is connected to the skirt portion of the cap by separate frangible members 7 and includes a radially inwardly extending locking means in the form of an inwardly directed protrusion or rib 8 extending
25 completely around the inner periphery of the ring. The locking means is adapted to slide over a rib or shoulder 9 on the outside surface of the container neck as the cap is threaded onto the container. With the cap fully threaded onto the container, the locking means is positioned under the
30 shoulder 9 so that upon unthreading of the cap, upward movement of the pilfer-proof ring will be blocked thereby. The frangible members 7 connecting the ring to the skirt are constructed so that they will break away as the ring engages the shoulder 9. This puts the members 7 in tension and at
35 the same time causes the ring to expand outwardly, in turn,

causing flexing of the members. The combined pulling and flexing of the frangible members causes their breaking. More particularly, as the cap is unthreaded from the bottle neck 6, the skirt 2 is moved upward and pulls the ring 3 upward therewith. Upward movement of the ring 3 is resisted however by contact between the rib 8 and the shoulder 9. This contact and resistance, first, develops tensile forces on the frangible members 7 connecting the ring 3 to the skirt 2 and second, forces the rib 8 and those frangible members outwardly. The combination of the tensile forces and the outward flexing of the frangible members 7 breaks the members, separating the ring 3 from the skirt 2. The skirt 2 is then completely unthreaded from the bottle neck 6, opening the bottle and leaving the ring 3 behind.

15 In accordance with the teachings of the present invention, the frangible members 7 are axially aligned with both the skirt and ring portions of the cap adjacent the outside surface of the skirt. They also are constructed with a sufficient cross-sectional dimension so as to provide axial
20 rigidity between the skirt and the ring upon subjecting the ring to an axial compressive force directed toward the skirt. This construction facilitates removal of the molded cap from the internal die member 10 on which it is formed. Removal is effected by pushing the cap off the internal die member by a
25 stripper ring 10'. The pushing force is exerted against the bottom of the pilfer-proof ring as indicated in Fig. 1. Due to the axial alignment of the frangible members 7 with both the ring and skirt and also due to the cross-section thickness of the frangible members, the force exerted on the
30 bottom of the ring puts the members in compression. The pushing force is directed in a generally straight line through the ring, frangible members and skirt with the result that there is little bending moment created.

The cap generally expands radially outwardly as it
35 is removed from the internal die member 10. Partial removal

of the cap from the die member is shown in Fig. 1. There it is seen that the internal thread 4 of the cap as it engages against the external thread 11 on the die member 10 effects a camming of the skirt portion of the cap radially outwardly of the die member. The skirt actually expands as it is cammed over the die threads. At the same time the upper surface 12 of the locking protrusion 8 on the pilfer-proof ring engages against the complementary shaped wall surface 13 of the internal die member. This engagement effects a camming of the ring in a radially outwardly direction to cause it to expand at the same time the skirt is being cammed and expanded radially outwardly.

Due to the location of the frangible members and the rigidity provided by their cross-sectional thickness, the skirt and ring expand more or less as an integral unit without flexing of the ring relative to the skirt to an extent which would cause breaking of the frangible members. Removal of the molded cap from the internal die member can therefore be accomplished with a simple pushing operation. Complicated collapsible male die structure is not required.

In the preferred embodiment of the present invention the inwardly directed protrusion 8 of the locking portion of the pilfer-proof ring has an axial cross-section which is generally conical in shape. That is, this cross-section of protrusion 8 has a shape generally similar to the shape of an axial cross-section of a solid cone. The upper surface 12 of this protrusion is a straight surface; and as shown in Fig. 2, this surface is disposed at an angle about equal to the angle at which the shoulder 9 of the container extends. The bottom surface of the protrusion has an axially downwardly facing convex surface 14. These surfaces facilitate connection of the cap to the container and retention of the ring on the container upon removal of the cap. More particularly, the flat surface 12 engages against the complementary shaped surface of the shoulder 9 whereby

axial unthreading of the cap produces a pulling effect on the ring and the frangible members to put them in tension. The tensioning or pulling on the frangible members together with their simultaneous flexing as the ring is cammed outwardly over the shoulder 9 of the bottle causes the frangible members to break.

The convex shape of the bottom surface 14 of the protrusion 8 of the pilfer-proof ring assists in camming the ring over the threads 5 of the container neck as the cap is threaded onto the container. Again, engagement of the bottom of the ring against the threads produces some compressive force through the ring, frangible members and skirt coupling these members together as an integral unit to thereby prevent undue flexing of the ring relative to the skirt. And without any simultaneous pulling of the frangible members as occurs upon removing the cap from the container, they do not break.

As shown in Figs. 1 and 2, the radially inwardly most surface of the protrusion 8 of the pilfer-proof ring is provided with multiple circumferentially spaced areas 15 disposed radially outwardly of the remainder of this surface. Although these areas 15 are located radially outwardly of the innermost extent of the protrusion, they will, nevertheless, be located under the shoulder 9 of the container when the cap is fully threaded onto the container. This is shown in Fig. 2. Accordingly, engagement of the upper surface 12 of the protrusion with the shoulder 9 occurs at all points around the pilfer-proof ring.

In the preferred embodiment, the circumferentially spaced areas are curved to define radially inwardly facing curved portions and they are evenly spaced from each other. Together they extend over one-half of the inner periphery of the protrusion 8. There are eight such areas spaced about the internal periphery and each area covers a circumferential distance of about $22\frac{1}{2}^{\circ}$. The remainder of the inner surface of the protrusion 8 is formed as flats 16. These

flats define chordal portions, spaced between the curved portions of the protrusion, and are aligned with the frangible members 7.

5 Figs. 5 through 10 illustrate in detail the presently preferred continuation of a mold 50 for forming the cap of Figs. 3 and 4. Mold 50 comprises a female member 52 and a male member 54. The female member 52 forms a socket 56 and an orifice 58 for conducting plastic material, such as polypropylene, into that socket. More specifically, a cavity
10 plate 60 of female member 52 forms a central opening 62 and a mold piece 64, which forms an upper portion of the socket 56, is disposed therein. A clamp plate 66 extends over the mold piece 64 and over the cavity plate 60 and is bolted to the cavity plate to clamp the mold piece within the central
15 opening 62. A material conduit 70 is secured to the clamp plate 66 and forms an upper portion of the orifice 58. One or more water passages 72 extend through female member 52, adjacent the socket 56, to conduct water through the female member of the mold 50 to cool material fed into the socket
20 56.

A plurality of cams 74 together form a lower portion of the socket 56, and these cams include radial projections 76 that engage circumferentially spaced section of male member 52, specifically a core assembly 78 thereof,
25 to form the annular recess of the cap between frangible members 16 thereof. The cams 74 rest on and are supported by the male member 54 specifically a top surface 80 thereof, for sliding movement between a closed position, shown in Fig 5, wherein the cams engage core assembly 78, and an open
30 position, shown in Fig 6, wherein the cams are spaced from the core assembly to facilitate removing cap from the mold cavity in which the cap is formed.

A spring 82 is provided to urge the cams 74 from their closed position to their open position. In particular,
35 the spring 82 is a conventional clip spring with a circular

shape and is positioned¹¹ against radially inwardly facing surfaces of the cams 74, urging those cams radially outwardly, away from the core assembly 78. A groove is formed in these radially inwardly facing surfaces of the cams 74 to hold the spring 82. A plurality of screws or bolts 84 are threaded into the top surface 80 of male member 54 to limit outward movement of the cams 74. Means other than springs 82 may be used to move cams 74 to their open positions. For instance a plurality of pins may be connected to the cavity plate 60 and slant downwardly outwardly into sockets formed in the cams, whereby the pins would push the cams outwardly when the cavity plate 60 is raised and push the cams 74 inwardly when the cavity plate is lowered. Also, means 86 (illustrated in Fig. 7) such as L-shaped pins, rails, pins, or similar devices may be secured to the surface 80 to guide movement of the cams 74 between their open and closed positions and to hold those cams against upward axial movement away from the surface 80.

With the embodiment of mold 50 illustrated in the drawings, the cams 74 are moved from their open position to their closed position and are releasably held in the latter position by means of engagement between cooperating surfaces of the cams and the cavity plate 60. More specifically, the cams 74 have upper surfaces 90 that slant upwardly radially inwardly, and cavity plate 60 has a lower surface 92 directly above the upper surfaces 90 of the cams and that also slants upwardly radially inwardly. As cavity plate 60 moves downwardly from its open position, shown in Fig. 6, to its closed position, shown in Fig. 3, the surface 92 of the cavity plate contacts the surfaces 90 of the cams 74 and forces those cams radially inwardly to their closed position. As the cavity plate 60 is held in its closed position, the surface 92 holds the cams 74 in their closed position.

With particular reference to Fig. 7, inside edges of the radial protrusions 76 of the cams 74 have a plurality

of circumferentially spaced grooves 94. When cams 74 are in their closed position, the grooves 94 form openings extending between the cams and the core assembly 78. The frangible members 7 of the cap are formed in those openings. Also, while the embodiment of mold 50 shown in the drawings includes four cams 74, the mold may be provided with fewer or more cams, for example two, six, or eight, without departing from the scope of the present invention.

As outlined above, cavity plate 60, mold piece 64, clamp plate 66, and material conduit 70 comprise an upper assembly of female member 52 of mold 50; and cams 74, spring 82, and guide means 86 comprise a lower assembly of the female member.

A support assembly 96 of male member 54 provides a base of support for the female member 52 and the other parts of the male member of the mold 50. Plates 98 and 100 of the assembly 96 are generally horizontal and parallel, and these plates form generally aligned central openings 102 and 104 respectively. Spacer blocks 106 and 110 of the support assembly 96 extend between the plates 98 and 100, across the bottom left and right sides of the mold 50. The various plates and blocks of the support assembly 96 are secured together by a plurality of bolts to form a rigid, unitary assembly.

With respect to the core assembly 78 of male member 54, when the mold 50 is in the closed, or cap forming position, shown in Fig. 5, the core assembly 78 axially extended into the socket 56 to form, with the female member 52, the particular mold cavity in which the cap is formed. More specifically, an outer core piece 112 rests on the upper plate 98 of the support assembly 96 and extended axially upwardly therefrom. The upper portion of the outer core piece 112 extends into the socket 56 of the female member 52 and, during formation of cap, forms the interior of the sides and a portion of the interior of the top of the cap. The

upper portion of the outer core piece 112 includes a first recess 114 which is used to form the rib 8 on the ring of the cap and a second annular recess 116 to form the threads 4 of the cap.

5 The outer core piece 112 is axially held in place by means of a retainer sleeve 118 and a retainer ring 120. The bottom portion of the outer core piece 112 includes a radially outwardly extending shoulder, and the retainer sleeve 118 includes a downwardly facing radial surface that
10 extends directly over that shoulder of the outer core member. In turn, the lower portion of the retainer sleeve 118 includes a radially outwardly extending shoulder, and the retainer ring 120 includes a downwardly facing radial surface that extends directly over that shoulder of the retainer
15 sleeve. The retainer ring 120 itself is securely bolted to the top plate 98 of support assembly 96.

 The interior of the outer core piece 112 forms an axial through bore, and an inner core piece 104 extends therein and is supported for axial movement relative to the
20 outer core piece. The upper portions of the inner core piece 122 and the through bore of outer core piece 112 are both flared out. In the closed position shown in Fig. 5, the top surface of the inner core piece 122 is substantially coplanar with the top surface of the outer core piece 112 and, during
25 formation of the cap, forms the major portion of the interior surface of the top of the cap. The outer and inner core pieces 112 and 122 together form a top axial recess 124 in which top annular sealing member 26 of the cap is formed, and the inner core piece 122 forms a top axially slanted recess
30 126 in which the top annular sealing member 30 of the cap is formed. Preferably, the inner core piece 122 includes a separable upper insert that is in a tight pressure fit with the main body of the inner core piece, and these two pieces in combination form the recess 126.

The inner core piece 122 also defines an axial through bore and a knockout pin 130 axially extends therein and is supported for axial movement relative to the inner core piece. The knockout pin 130 generally is a smooth, solid cylinder, with a small annular shoulder 132 extending outward from the bottom of the pin. When the mold 50 is in the closed position shown in Fig. 5, the top surface of the knockout pin 130 is coplanar with the top surface of the inner core piece 122, and the knockout pin extends downwardly therefrom, through the inner core member, to a position below the bottom thereof. One or more water passages 134 extend through the knockout pin 130 to conduct water therethrough, adjacent the mold cavity in which the cap is formed, to cool material fed into the mold cavity.

A stripping assembly 136 is provided to push cap axially off core assembly 78. The stripping assembly 136 includes a ring 138 and a plate 140. Ring 138 extends around core assembly 78, below the mold cavity in which the cap is formed, to push the bottom of the cap off the core assembly, and the ring 138 rests directly on plate 140 so that upward movement of the plate 140 moves the ring 138 upwardly. When the mold 50 is in the closed position shown in Fig. 5, and upper portion of ring 138 tightly fits around an intermediate portion of outer core piece 112 and forms the bottom of the mold cavity in which cap is formed. An outer portion of ring 138 forms a radially outwardly extending shoulder 142 that rests on the top surface 80 of the plate 140. This engagement between shoulder 142 and surface 80 forces ring 138 upward with plate 140. A lower portion of ring 138 axially extends into a central opening 146 of plate 140, in a close radial fit therewith, to hold the ring 138 securely in place, around core assembly 78.

The plate 140 directly rests on the top support plates 98 when the mold 50 is in the closed position shown in Fig. 5. When cavity plate 60 and mold piece 64 of female

member 52 are moved upward away from their closed position shown in Fig. 5, the plate 140 is free to move upward away from support plate 98 for a limited distance, and means such as springs 150 are provided to move the plate 140 upward relative to that support plate. More particularly, the plate 140 and support plate 98 form a plurality of recesses, and springs 150, which may be conventional coil springs, are located in these recesses, urging plates 140 and 98 axially apart. Of course, means other than conventional coil springs, for example air or hydraulic cylinders, may be used to move the plate 140 away from the support plate 98. Means such as bolts 152 (only one is shown in the drawings), may be used to guide axial movement of the plate 140 away from and towards support plate 98 and to limit axial movement of the plate 140 away from that support plate.

A first ejector assembly 154 is located between plates 92, 94, 96 and 100, and engages the inner core piece 122 to push that core piece upward to help push the cap 10 off the outer core piece 112. Plates 156 and 158 of the ejector assembly 154 form central openings, with the inner core member 122 extending through those openings in a close radial fit with the surfaces thereof. Bolts 152 extend between the plate 156 and the plate 140 to move the former plate axially upward with the latter plate, and bolts 160 (only one is shown in the drawings) connect the plate 158 to the plate 156 for unitary axial movement. A retainer ring 162, which may be a conventional snap ring, is secured within an annular groove formed in the lower portion of the outside surface of the interior core member 122, extends radially outward therefrom, and is tightly captured between the plates 156 and 158. In this manner, upward movement of the plate 158 forces the ring 162, and thus the core member 122, upward therewith; while downward movement of the plate 156 forces the ring 162, and hence the core member 122, downward therewith.

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A second ejector assembly 164 is located directly below the first ejector assembly 154 and engages the knockout pin 130 to push that pin upward. A plate 166 of the second ejector assembly 164 extends directly below and contacts the bottom of the knockout pin 130. Another plate 168 of the ejector assembly 164 is located above the plate 166, is connected thereto by means of bolts 170 (only one is shown in the drawings), and forms a central axial opening through which the knockout pin 130 extends.

10 The plate 168 forms a downwardly facing radial surface that extends directly over the shoulder 132 of the knockout pin 130. With this arrangement, upward movement of the plate 166 forces the knockout pin 130 upward therewith via the direct contact between the plate 166 and the knockout pin; while downward movement of the plate 166 forces the knockout pin downward therewith via the bolts 170, the plate 168, and the shoulder 132. The plate 166, in turn, is connected to a pair of knockout bars 174 by connecting pins 176 for unitary upward and downward movement therewith.

15 Bolts 178 (only one is shown in the drawings) are secured to the plate 158 of the first ejector assembly 154 and extend through the plates 166 and 168 of the second ejector assembly 164 to guide axial movement of the second ejector assembly within the mold 50. The bolts 178 also serve to pull the first ejector assembly 154 downward with the second ejector assembly 164 after the former assembly has moved a pre-set, limited distance downward relative to the latter assembly.

In operation, the mold 50 is connected to a molding apparatus 180, schematically shown in Fig. 11, that first, supports the mold 50, and second, operates to raise and to lower the knockout bars 174, the upper assembly of the female member 52, and the stripping assembly 136 of the male member 54. As a practical matter, it will normally be more economical to connect a multitude of the molds 50 to a single molding apparatus. If this is done, it should be observed,

molding apparatus. If this is done, it should be observed, it is not necessary to provide each mold 50 with separate means for raising the cap, stripper mechanism 136 of the mold. For instance, a molding apparatus that carries twenty
5 or thirty molds 50 may use two, four, or six air cylinders 182 to raise the cap stripper mechanisms of the molds.

With reference to Fig 5, to form the container cap, plastic material, such as polypropylene, is injected through the orifice 158 to fill the mold cavity formed between the
10 female and male members 52 and 54. Cooling water is conducted through the water passages 72 and 134 of the mold 50, and the plastic material in the mold cavity cools and hardens. This cooling of female and male members 52 and 54 -- in particular, the rate at which the cooling water is
15 conducted through those members -- is controlled so that the temperature of the portion of the male member adjacent the cap is maintained below the temperature of the portion of the female member adjacent the cap. For example, the portion of the male member 52 adjacent the mold cavity in which the cap
20 is formed may be maintained at 400°F while the portion of the female member 54 adjacent that mold cavity may be maintained at 600°F. Because of this temperature difference, as the plastic material in the mold cavity hardens, the material in the mold cavity shrinks onto the male member 52, specifically
25 the core assembly 78 thereof, and a space develops between the cap and the female member 54, specifically mold piece 64 thereof.

Once the cap hardens, the female member 54 is removed from the cap. With reference to Figures 4 and 9,
30 this is done by moving the upper assembly of the female member 54 upwardly axially and the lower assembly of the female member 54 radially away from the cap. This is done by expanding cylinders 184 of molding apparatus 180, which raises plate 186 thereof, which in turn, raises clamp plate
35 66, cavity plate 60, and mold piece 64 of mold 50. Since the

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releasably held in their closed position by the pressure exerted on the cams by the cavity plate 60, as soon as the cavity plate is moved away from the cams, those cams automatically slide outward along the surface 80, away from the cap.

It should be observed that, because of the space developed between the mold piece 64 and the cap, that mold piece does not rub against or tend to tear or to pull the cap apart as the upper assembly is moved away from the cap. This, of course, facilitate moving the mold piece 64 away from the cap and ensures that the mold piece does not weaken or otherwise deleteriously affect the container cap as the mold piece moves away therefrom. This permits the molding of cap wherein the outer wall surface of the skirt portion of the cap is at a right angle to the top of the cap rather than tapered outwardly downwardly therefrom.

Next, the cap is removed from the male member 54. This is done through coordinated movement of the stripping assembly 136, the inner core piece 122, the knockout pin 130, and the first and second ejector assemblies 154 and 164. As the cavity plate 60 of the female member 52 is moved upwardly, the plate 140 becomes free to move upwardly, and the plate 140 is moved upwardly by the springs 150. Alternatively, with the arrangement depicted in Fig. 11, plate 140 may be moved upwardly by means of cylinders 182 plate 190, which is rigidly secured to the plates 140 of the molds 50 shown in Fig. 11. As the plate 140 is pushed upwardly, that plate, first, pushes the ring 138 upwardly; and second, pulls the bolts 152, the first ejector assembly 154, and the inner core member 122 of the core assembly 78 upwardly. With reference to Fig. 9, as the ring 138 is pushed upwardly, this ring, in turn, pushes the bottom of the cap upwardly, pushing the rib 8 and the threads 4 out of the recesses 114 and 116 of the outer core piece 112.

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Because the rib 8 is pushed -- as opposed to pulled -- out of the recess 114, the frangible members 7 of the cap are not stretched, but rather are compressed, as the rib 8 is removed from the recess in which the rib 8 is formed. Thus, the cap may be removed from the mold 50 without exerting appreciable tensile forces on the frangible members 7.

At the same time that the ring 138 is pushing the bottom of the cap upwardly, the inner core piece 122 and the knockout pin 130 are moved upwardly to push the top of the container cap away from the outer core piece 112. The inner core piece 122 is moved upwardly by means of the first ejector assembly 154 which, as discussed above, is pulled upwardly with the plate 140 by means of the bolts 152. The knockout pin 130 is pushed upwardly by the second ejector assembly 164, which itself is moved upwardly by the knockout bars 174. The knockout bars 174 are pushed via cylinders 192 and plate 194 of molding apparatus 180.

The stripper plate 140, the ring 138, the first ejector assembly 154, and the inner core piece 122 continue to move upwardly until the plate 156 of the first ejector assembly abuts against the plate 98, as shown in Fig 6, terminating the upwardly movement of the plate 156, the first ejector assembly, and the inner core piece. At this time, the plate 156 of the ejector assembly 154 also prevents further upwardly movement of the bolts 152, preventing further upwardly movement of the plate 140. Because the plate 140 can no longer move upwardly, that plate does not force the cams 74 or the ring 38 further upwardly, and the cams and the ring 138 come to a stop. The position of the plate 140, the ring 138, the inner core piece 122, and the knockout pin 130 when upwardly movement of the plate 140, the ring 138, and the inner core piece is terminated is shown in Fig. 8. It should be noted that the ring 138 is employed to push the rib 8 of the cap past the recess 116 in which the threads 8 of the container cap are formed. In this way, the

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frangible members 7 of the cap are not stretched in case the rib 8 rubs against upper surfaces of the recess 116 as that rib slides upwardly therepast.

5 The knockout pin 130 is free to continue to move upwardly from the position shown in Fig. 10, however, and the knockout pin is so moved by further upwardly movement of the second ejector assembly 164. The knockout pin 130 directly contacts the central portion of the top of the cap, and as the knockout pin is pushed upwardly, the knockout pin forces
10 the cap completely off and away from the outer and the inner core pieces 112 and 122, from the position shown in Fig. 10 to the position shown in broken lines in Fig. 6. From this position, the cap may be lifted off the knockout pin 130, and completely removed from the mold 50 by hand.

15 Once the cap is removed, the knockout bars 174 are pulled downwardly to the position in Fig 5, pulling the second ejector assembly 164 and the knockout pin 130 downwardly into their position shown in Fig. 5. As the top plate 168 of the second ejector assembly 164 moves
20 downwardly, that plate engages the head of the bolt 178 and pulls that bolt downwardly. This pulls the plate 158 of the first ejector assembly 154 downwardly, and this pulls the plate 156 of that ejector assembly downwardly via the bolts 160. As the plate 156 is pulled downward, that plate forces
25 the inner core piece 102 downward via the retainer ring 162 and, at the same time, forces the bolts 152 downward, which in turn pulls the plate 140 downward. The ring 138 and the cams 74 are pulled downward with the plate 140. With the knockout pin 130, the inner core piece 112, the cams 74, the
30 stripping assembly 136, and the ejector assemblies 154 and 164 all moved downwardly, the upper assembly of the female member 52 is then moved downwardly into its closed position. This forces the cams 74 radially inwardly, into their closed position, rendering the mold 50 again ready for use.

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CLAIMS

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1. The improvement in a plastic pilfer-proof cap molded on an internal mold member and adapted for use with a container having a threaded neck portion and a radially
5 inwardly extending shoulder disposed below the threaded neck portion and facing axially therefrom, the cap having a top wall, a depending skirt with internal threading for engagement with the threaded neck portion of the container and a pilfer-proof ring connected to the lower end of the
10 skirt by frangible means and having radially inwardly extending locking means adapted to slide over the shoulder upon threading the cap onto the container and to engage against the shoulder upon unthreading of the cap to cause the frangible means to break and the ring to separate from the
15 skirt of the cap, the improvement wherein:

a) the frangible means is aligned axially with the skirt and ring and has a predetermined thickness

i) to provide axial rigidity between
20 the skirt and the ring to prevent substantial relative flexing and breaking thereof upon subjecting the ring to an axial compressive force directed toward the skirt as are encountered upon removal of the molded cap
25 from the internal mold member on which it is molded by pushing the cap off of said mold member, and

ii) causing the frangible means to
30 break when the frangible means is outwardly flexed and simultaneously is subjected to an axial tensile force directed toward the ring as are encountered upon removal of the molded cap from the container.

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2. The improvement in the cap according to claim
1 wherein:

5 a) the locking means includes a radially
inwardly directed protrusion extending around the
internal periphery of the ring.

3. The improvement in the cap according to claim
2 wherein:

10 a) the protrusion, in axial cross-section,
has a generally conical shape with the radially
inwardly facing surface having multiple
circumferentially spaced areas disposed radially
outwardly of the remainder of said surface, said
15 areas each defining a radially inwardly facing
curved portion and the remainder of said surface
defining chordal portions.

4. The improvement in the cap according to claim
3 wherein:

20 a) the circumferentially spaced areas are
positioned for location under the shoulder of the
container when the cap is fully threaded onto the
container.

25 5. The improvement in the cap according to claim
4 wherein:

a) the circumferentially spaced areas are
evenly spaced from each other and together cover
one-half of the inner surface of the locking means.

30 6. The improvement in the cap according to claim
5 wherein:

a) there are eight circumferentially spaced
areas.

7. The improvement in the cap according to any one of claim 3-6 wherein:

5 a) the frangible means includes separate members each one of which is axially aligned with one of the chordal portions of the locking means.

8. The improvement in the cap according to claim 7 wherein:

10 a) each of the frangible members:
i) has a thickness less than the thickness of the skirt, and
ii) the positioned adjacent the outer surface of the skirt.

15 9. The improvement in the cap according to claim 8 wherein:

20 a) the protrusion of the locking means has an axially upwardly facing straight surface disposed at an angle about equal to the angle at which the shoulder of the container extends.

10. The improvement in the cap according to claim 9 wherein:

25 a) the protrusion of the locking means has an axially downwardly facing convex surface.

30 11. A mold for forming a plastic cap having a side wall and a ring spaced from the side wall by means of circumferentially spaced annular recesses and connected to the side wall by frangible members, the mold comprising:

a) a female member forming a socket and an orifice for conducting plastic material into the socket;

b) a male member including a core assembly axially extending into the socket to form a mold cavity with the female member;

c) the female member including

i) an upper assembly forming an upper portion of the socket, and

ii) a lower assembly having a plurality of radially movable cam members forming a lower portion of the socket, the cam members having radial protrusions engaging circumferentially spaced sections of the core assembly of the male member to form the circumferentially spaced recesses in the cap.

12. A mold according to claim 11 wherein:

a) the cam members rest on and are supported by the male member for sliding movement between

i) a closed position wherein the radial protrusions of the cam members engage the core assembly of the male member, and

ii) an open position wherein the cam members are spaced from the core assembly of the male member to facilitate removing the cap from the mold cavity; and

b) the lower assembly further includes:

i) spring means engaging the cam members and urging the cam members to their open position,

ii) stop means to limit movement of the cam members at their open position, and

iii) means to guide movement of the cam members between their open and closed positions.

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13. A mold according to claim 12 wherein:

a) the cams include upper surfaces sloping upwardly radially inwardly;

b) the upper assembly includes a lower surface directly above the upper surfaces of the cams and sloping upwardly radially inwardly; and

c) said lower surface of the upper assembly is above and engages said upper surfaces of the cams to hold the cams releasably in the closed position.

14. A mold according to claim 13 wherein:

a) said lower surface of the upper assembly engages said upper surfaces of the cam members as the upper assembly moves axially downward to move the cam members from their open position to their closed position.

15. A mold according to claim 11 wherein:

a) the core assembly of the male member includes:

i) an outer piece having an annular recess to form an annular rib of the cap, and

ii) a knock out pin axially extending within the outer core piece and supported for axial movement relative thereto; and

b) the male member further includes:

i) an axially movable stripper assembly for engaging and pushing a bottom edge of the rib of the cap axially out of the annular recess of the outer core piece, and

ii) means connected to the knock out pin to move the knock out pin axially upwardly to push the cap off the outer core piece.

16. A mold according to claim 15 wherein:

- a) the stripper assembly includes a stripper ring extending around the core assembly to engage the bottom edge of the cap and to push the rib of the cap out of the annular recess of the outer core piece.

17. A mold according to claim 11 wherein:

- a) the core assembly of the male member includes:
- i) an outer core piece having a first annular recess to form an annular rib of the cap, and a second annular recess to form a thread of the cap, and
- ii) a knock out pin axially extending within the outer core piece and supported for axial movement relative thereto; and
- b) the male member further includes:
- i) an axially movable stripper assembly for engaging a bottom edge of the cap to push the rib of the cap axially out of the first annular recess and past the second annular recess of the outer core piece, and
- ii) means connected to the knock out pin to push the knockout pin axially upwardly to push the cap off the outer core piece.

18. A method of removing a plastic cap from a mold, the mold comprising female and male members, the female member including an upper assembly forming an upper portion of a socket, and a plurality of cams forming a lower portion of the socket, the male member axially extending into the socket to form a mold cavity between the male and female members in which the cap is formed, the method comprising the steps, of:

a) moving the upper assembly of the female member axially away from the cap;

b) moving the cams of the female member radially away from the cap; and

5 c) removing the cap from the male member.

19. A method according to claim 18 wherein the male member includes a first annular recess in which an annular rib of the cap is formed, and the step of removing
10 the cap from the male member includes:

a) pushing a bottom edge of the cap axially upwardly to push the annular rib out of the first annular recess.

15 20. A method according to claim 19 wherein the male member further includes a second annular recess located above the first annular recess and in which an annular thread of the cap is formed, and the step of removing the cap from the male member further includes:

20 a) pushing the bottom edge of the cap axially upwardly to push the annular rib past the second annular recess.

21. A method of removing a plastic cap from a
25 mold, the mold including male and female members forming a cavity therebetween in which the cap is formed, the method comprising the steps of:

a) shrinking the cap onto male component to develop a space between the cap and the female
30 component;

b) removing the female component from the cap; and

c) removing the cap from the male component.

22. A method according to claim 21 wherein the
35 mold cavity is formed by a first portion of the male member

and a first portion of the female member, and the shrinking step includes: -

- a) maintaining the first portion of the male member at a lower temperature than the first portion of the female member.

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AMENDED CLAIMS

[received by the International Bureau on 20 May 1985 (20.05.85);
original claims 1, 2, 3 and 8 amended; other claims unchanged (3 pages)]

1. (Amended) The improvement in a plastic pilfer-proof cap molded on an internal mold member and adapted for use with a container having a threaded neck portion and a radially inwardly extending shoulder disposed below the threaded neck portion and facing axially away therefrom, the cap having a top wall, a depending skirt with internal threading for engagement with the threaded neck portion of the container and a pilfer-proof ring connected to the lower end of the skirt by frangible means and having radially inwardly extending locking means adapted to slide over the shoulder upon threading the cap onto the container and to engage against the shoulder upon unthreading of the cap to cause the frangible means to break and the ring to separate from the skirt of the cap, the improvement wherein:
- a) the frangible means is aligned axially with the skirt and ring;
 - b) the locking means includes a radially inwardly directed protrusion extending around the internal periphery of the ring, the protrusion having a radially inwardly facing surface and multiple circumferentially spaced areas disposed radially outwardly of the remainder of said surface.

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2. (Amended) The improvement in the cap according to claim 1 wherein:

5 a) the frangible means includes separate members positioned between said multiple circumferentially spaced areas.

3. (Amended) The improvement in the cap according to claim 1 whjerein:

10 a) the protrusion, in axial cross-section, has a generally conical shape with the radially inwardly facing surface having multiple circumferentially spaced areas disposed radially outwardly of the remainder of said surface, said areas each defining a radially inwardly facing curved
15 portion and the remainder of said surface defining chordal portions.

4. The improvement in the cap acording to claim 3 wherein:

20 a) the circumferentially spaced areas are positioned for location under the shoulder of the container when the cap is fully threaded onto the container.

5. The improvement in the cap according to claim 4
25 wherein:

a) the circumferentially spaced areas are evenly spaced from each other and together cover one-half of the inner surface of the locking means.

30 6. The improvement in the cap according to claim 5 wherein:

a) there are eight circumferentially spaced areas.



7. The improvement in the cap according to any one of claims 3-6 wherein:

a) the frangible means includes separate members
5 each one of which is axially aligned with one of the chordal portions of the locking means.

8. (Amended) The improvement according to any one of claims 1, 2 or 7 wherein:

10 a) the frangible means includes separate members each having a thickness less than the thickness of the skirt and an outer surface axially aligned with the outermost surface of both the skirt and ring.

15 9. The improvement in the cap according to claim 8 wherein:

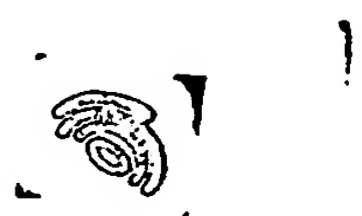
a) the protrusion of the locking means has an axially upwardly facing straight surface disposed at an angle about equal to the angle at which the shoulder of the
20 container extends.

10. The improvement in the cap according to claim 9 wherein:

a) the protrusion of the locking means has an
25 axially downwardly facing convex surface.

11. A mold for forming a plastic cap having a side wall and a ring spaced from the side wall by means of circumferentially spaced annular recesses and connected to
30 the side wall by frangible members, the mold comprising:

a) a female member forming a socket and an orifice for conducting plastic material into the socket;



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FIG. 1

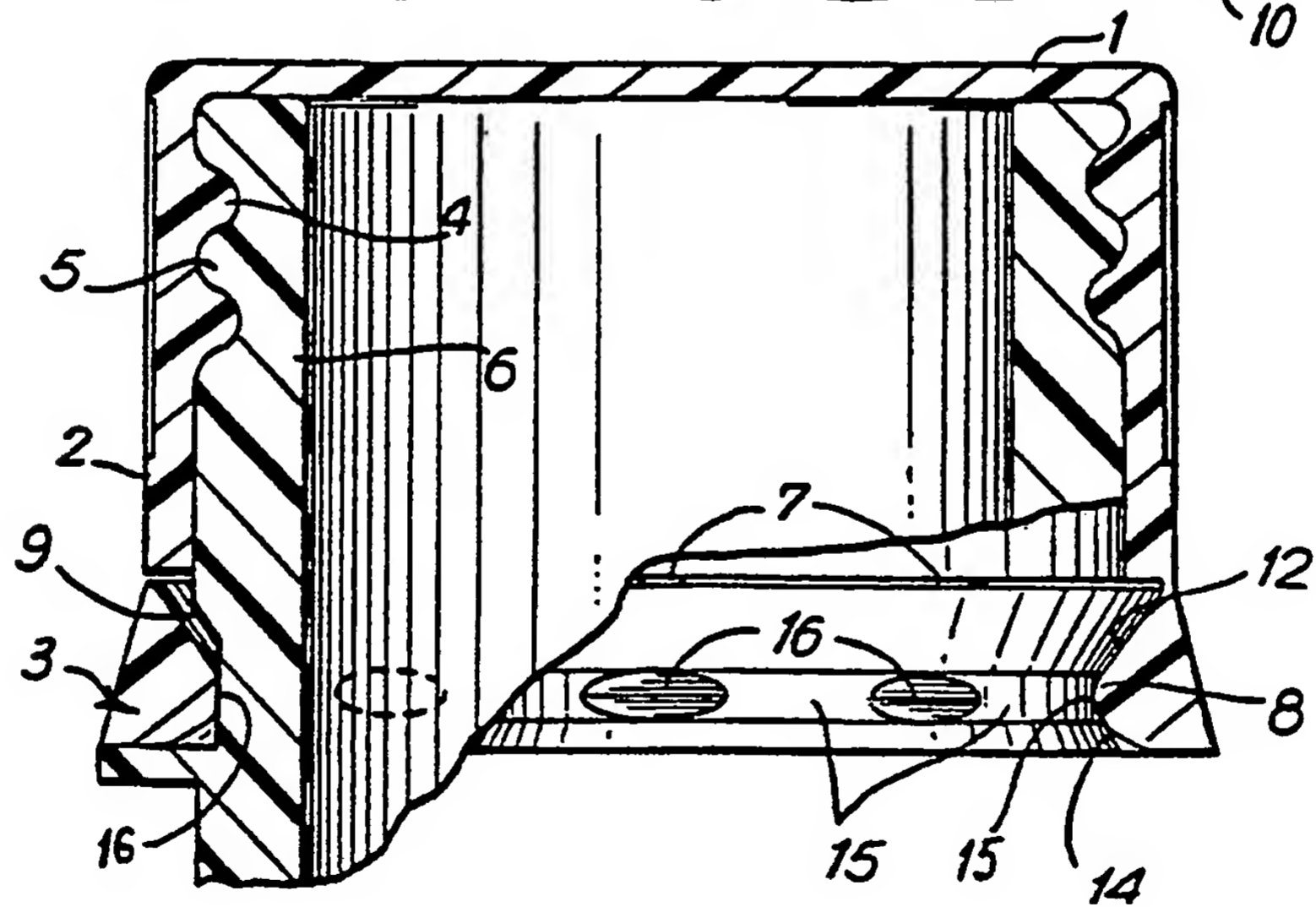
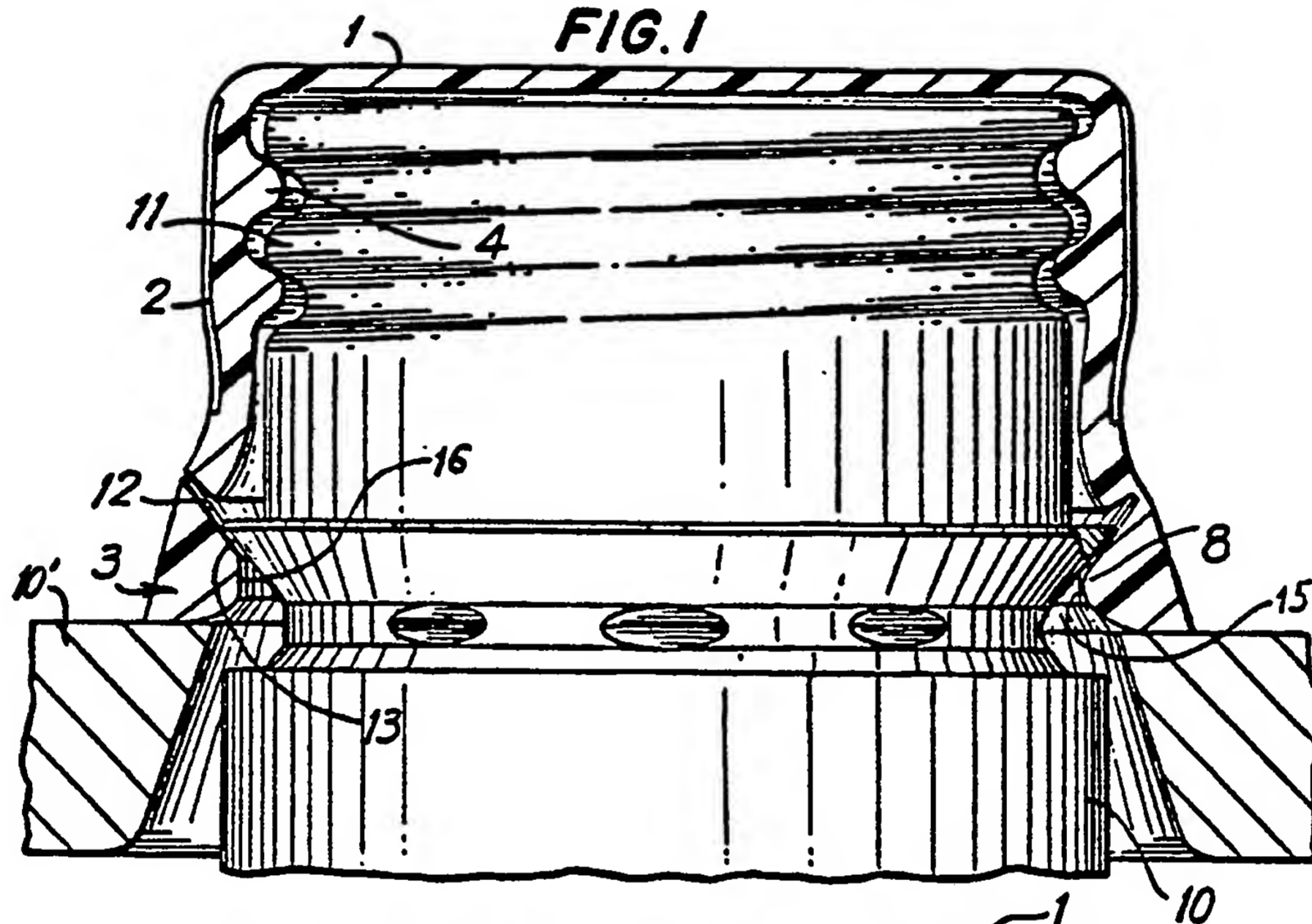


FIG. 2

FIG. 3

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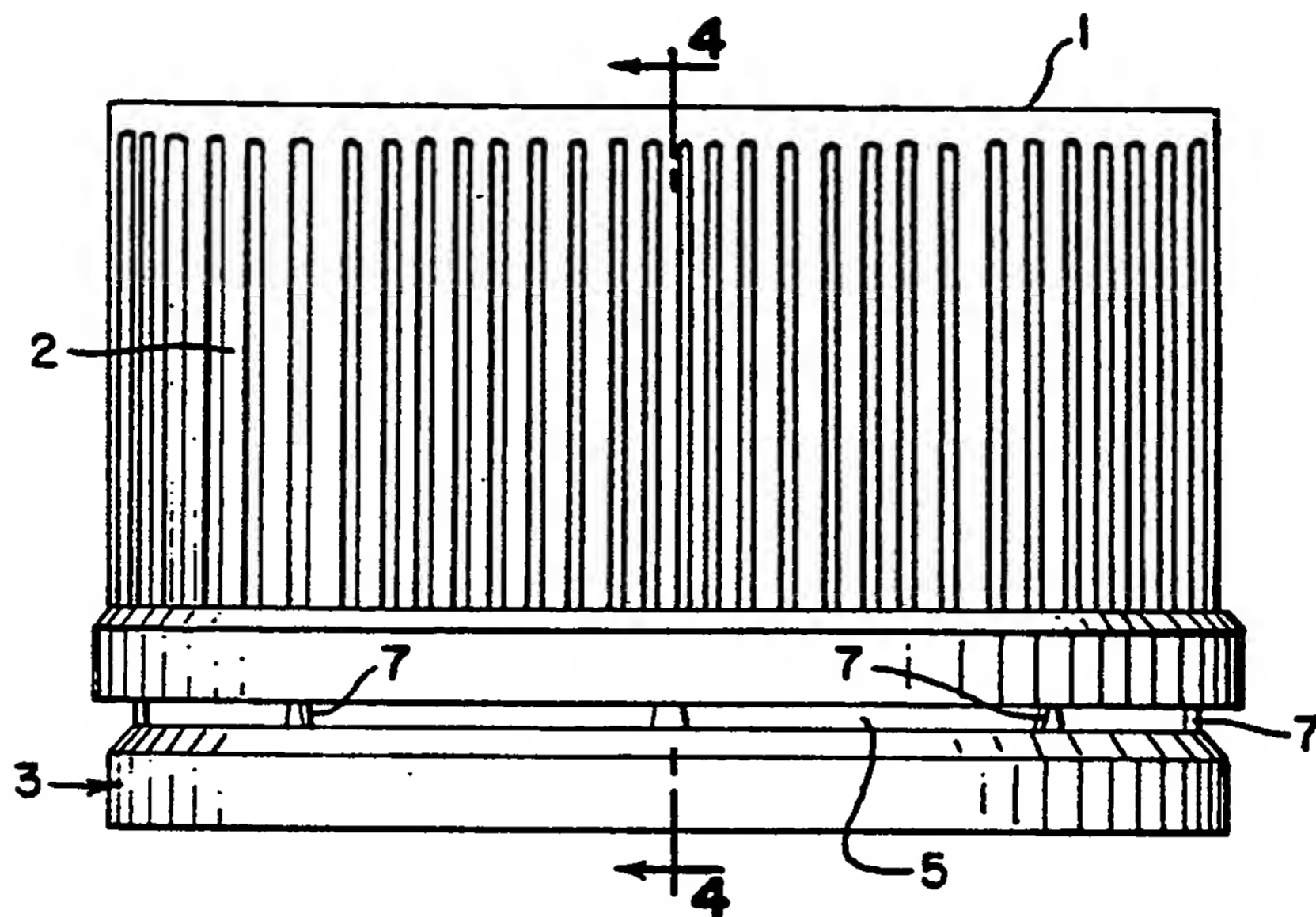


FIG. 4

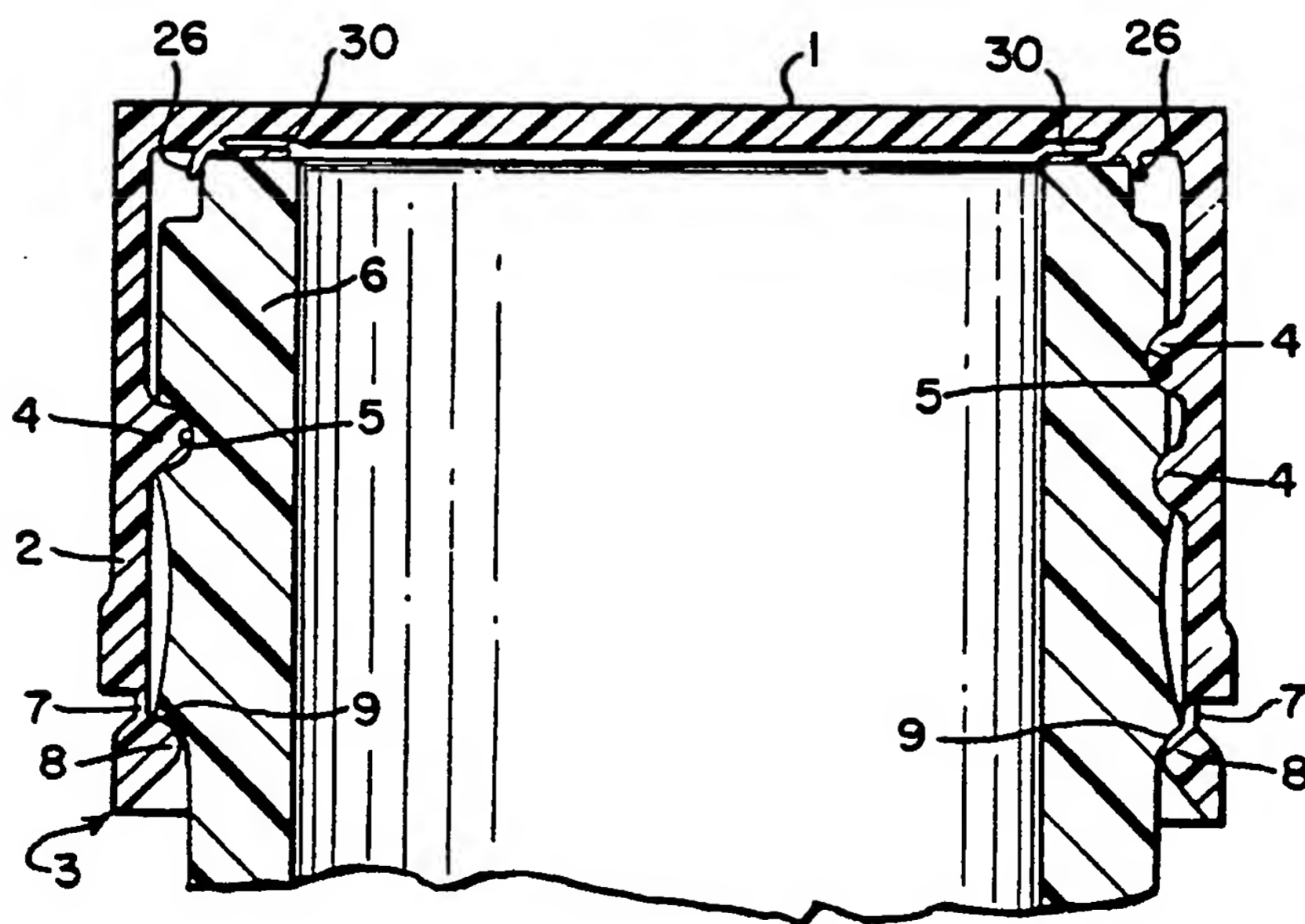


FIG. 5

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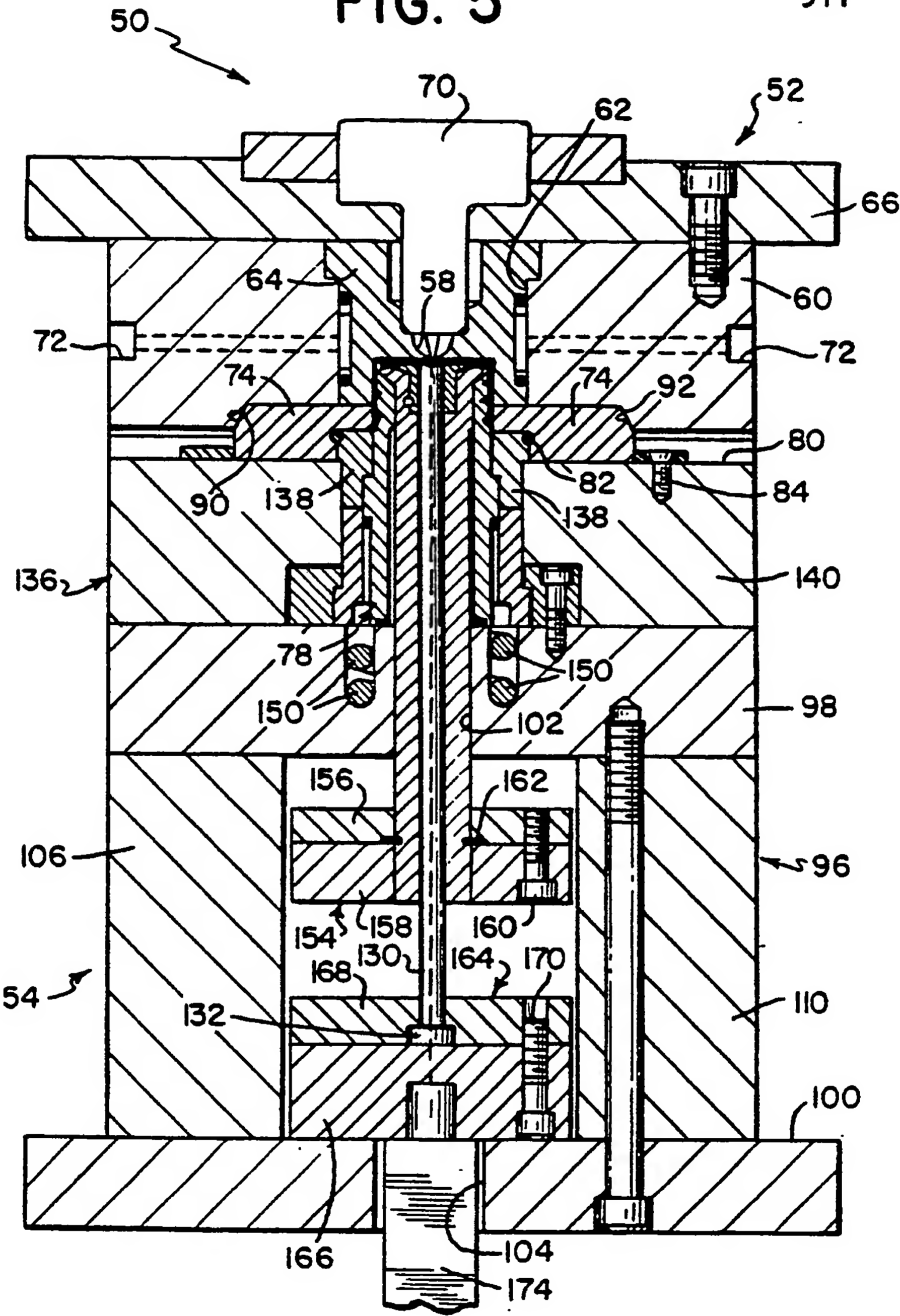
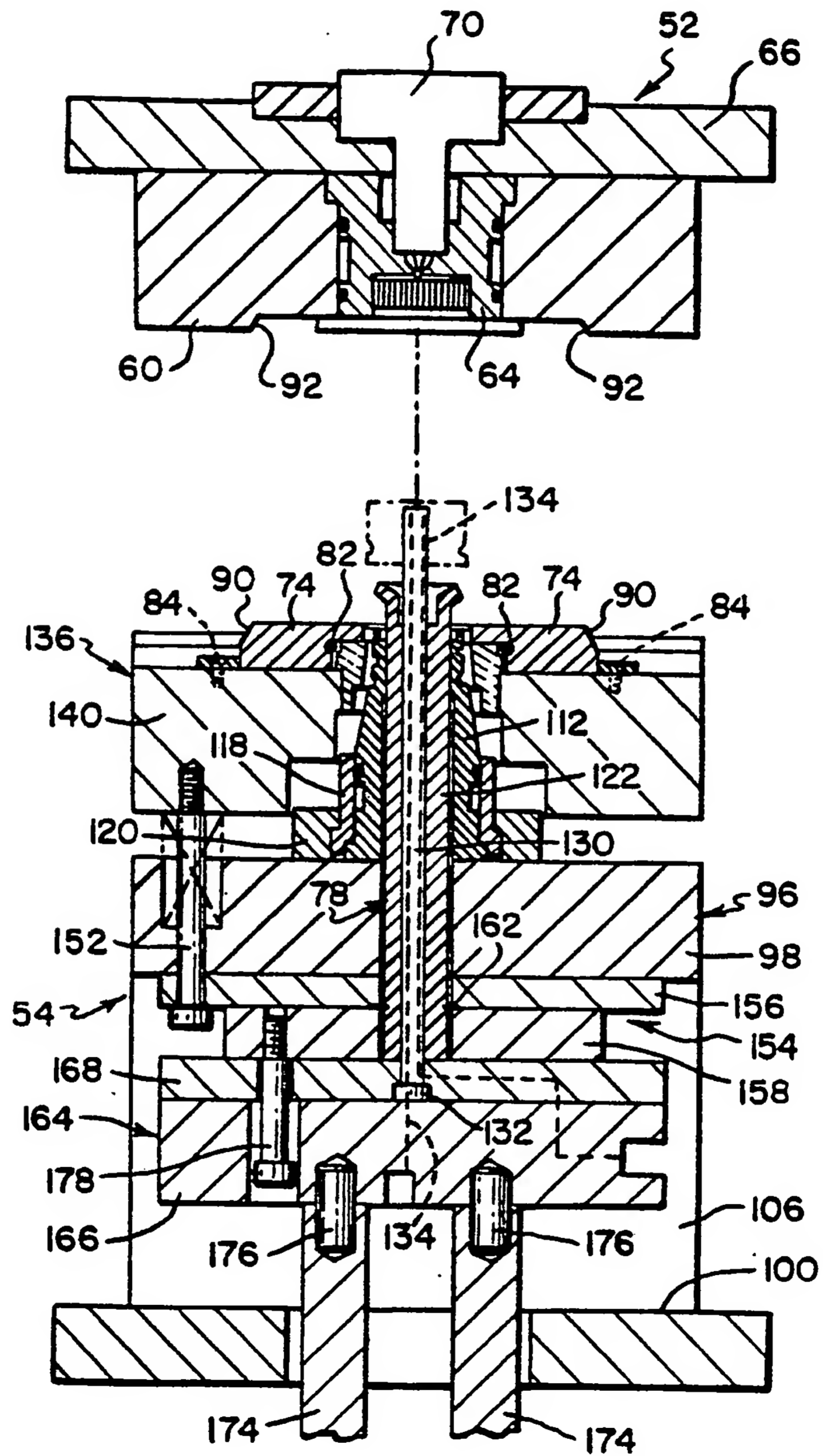


FIG. 6

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FIG. 7

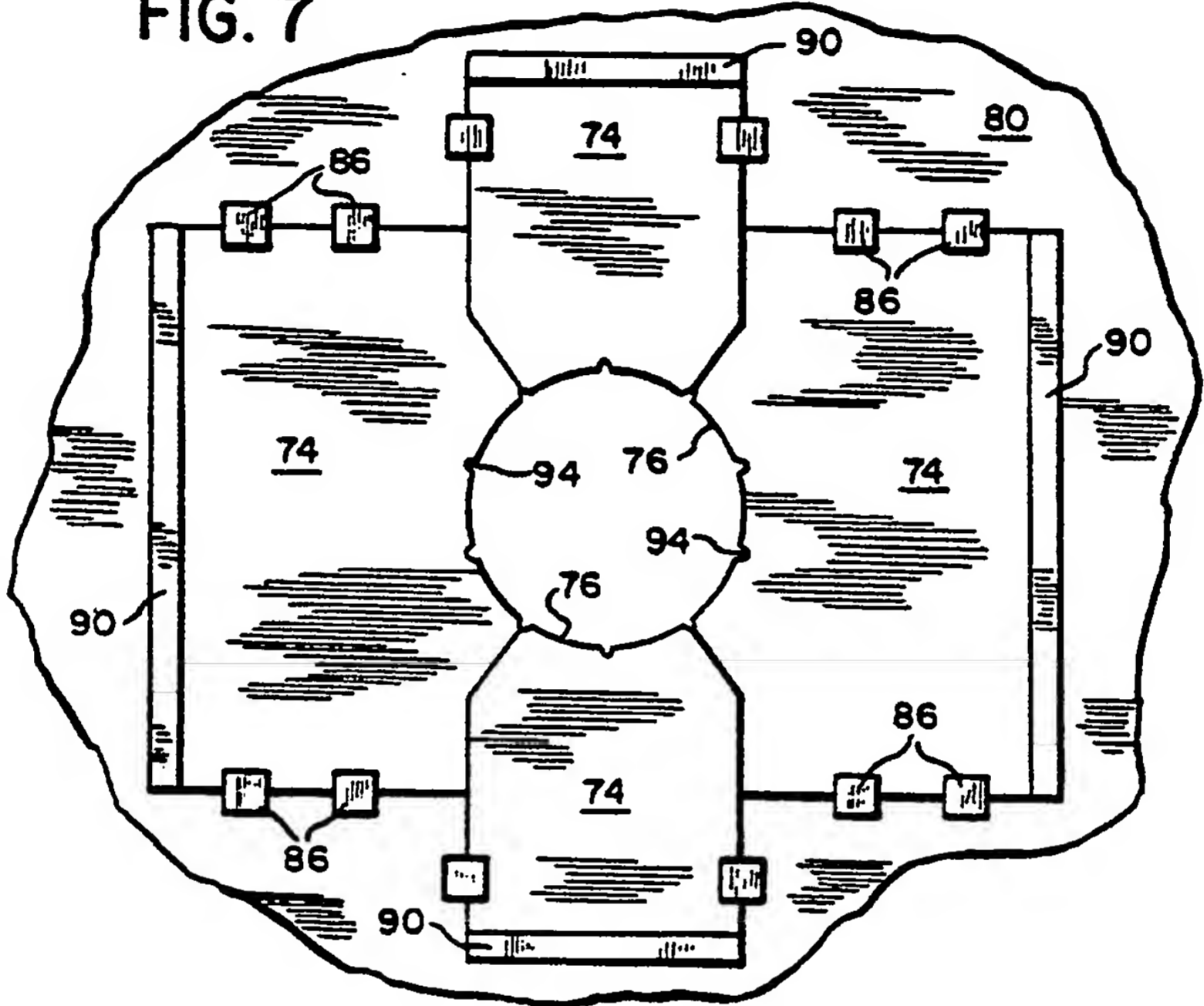


FIG. 8

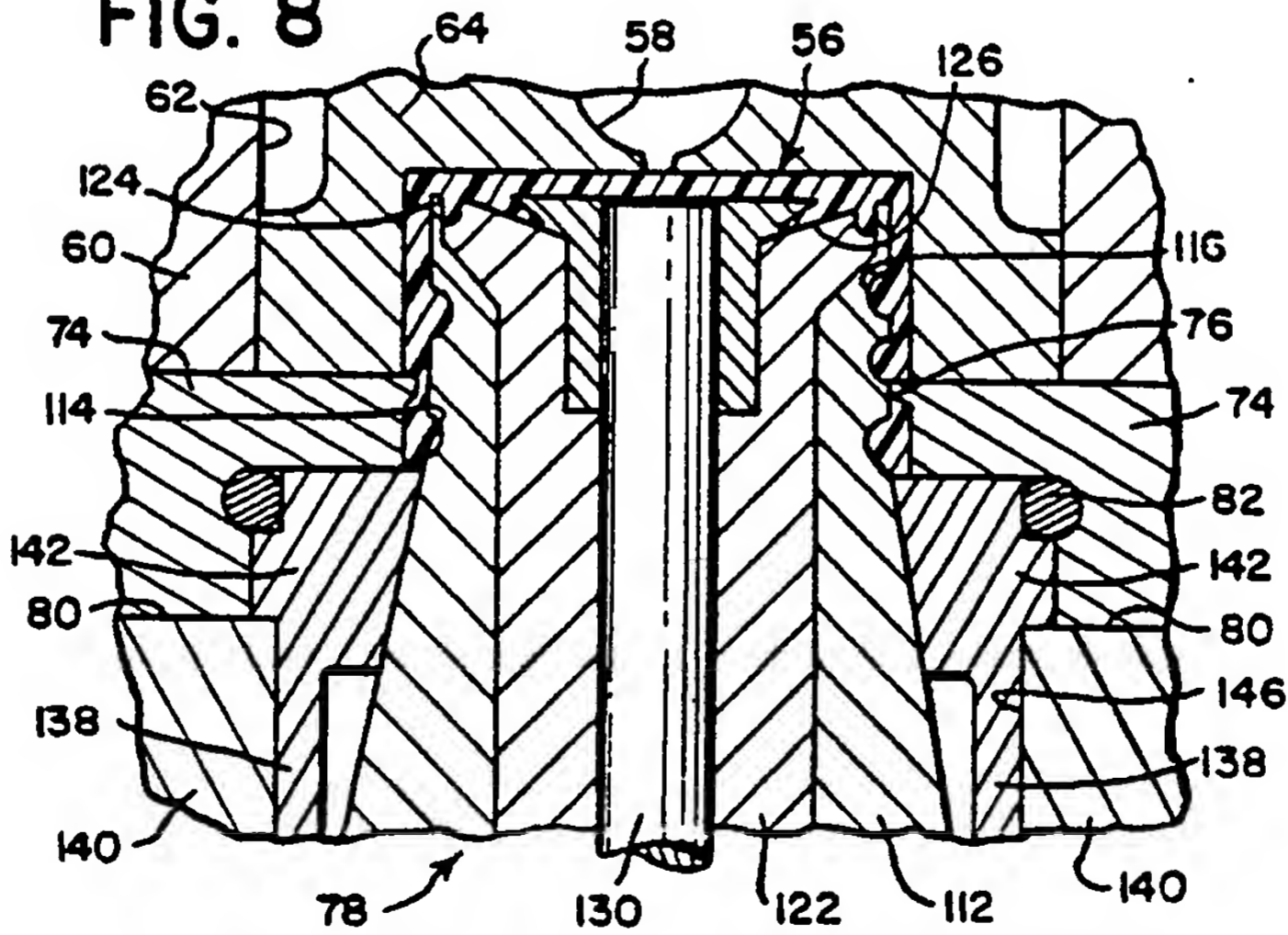


FIG. 9

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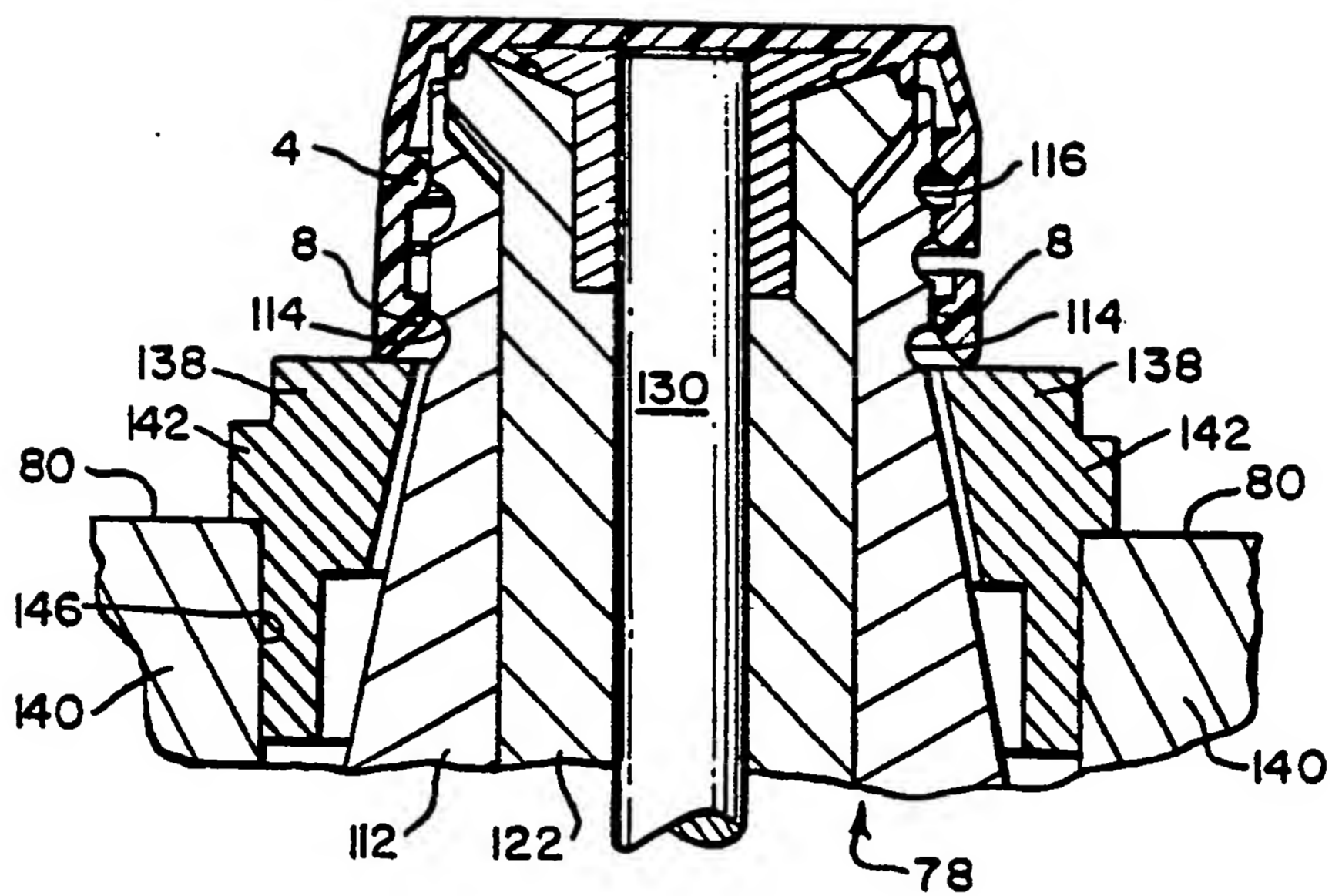
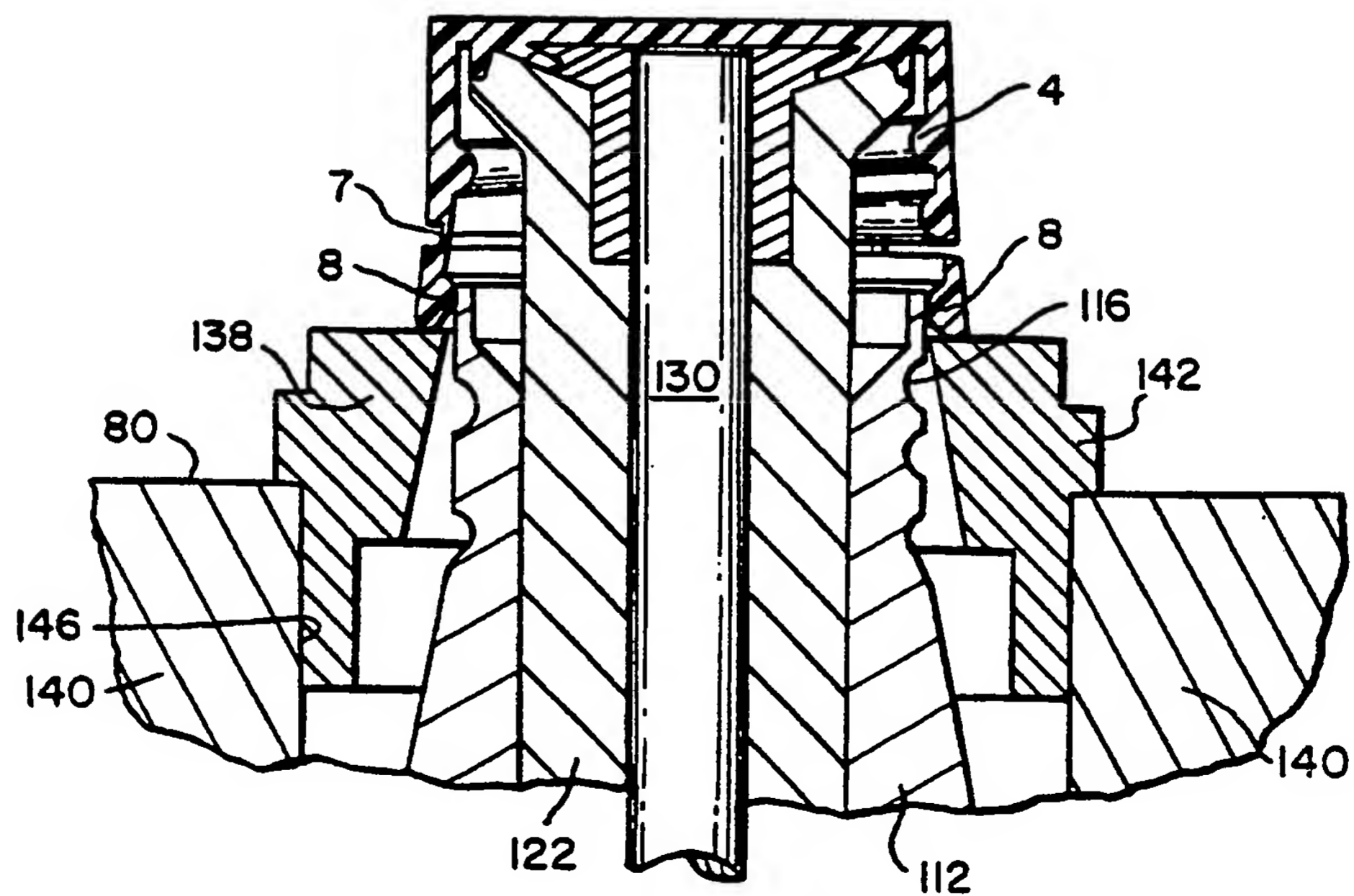


FIG. 10



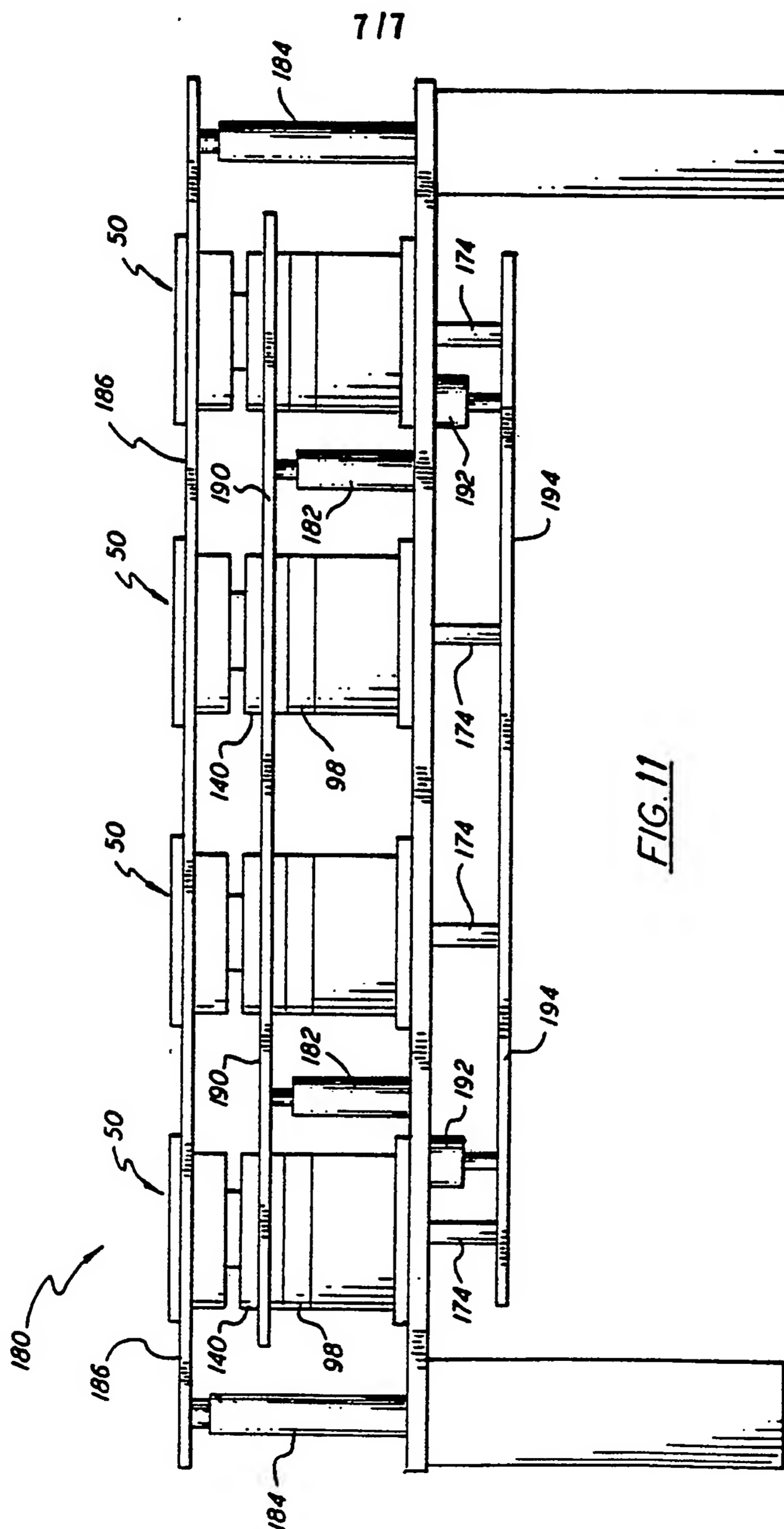


FIG. 11

INTERNATIONAL SEARCH REPORT

International Application No **PCT/US85/00289**

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ³		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl. B65D 41/34; B29F 1/14		
U.S. Cl. 215/252; 249/63,68; 264/318,324; 425/438		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁴		
Classification System	Classification Symbols	
U.S.	215/252 249/63,67,68 264/318,334 425/438	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched ⁵		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category ⁶	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
Y	US, A, 4,461,390, Published 24 July, 1984 (Csaszar)	1,2
Y,E	US, A, 4,503,985, Published 12 March, 1985 (Swartzbaugh et al)	3-10
Y	US, A, 4,196,818, Published 08 April 1980 (Brownbill)	3-10
A,P	US, A, 4,496,302, Published 29 January 1985 (Brown)	11-22
A	US, A, 3,905,740, Published 16 September 1975 (Lovejoy)	11-22
A	US, A, 3,940,103, Published 24 February 1976 (Hilaire)	11-22
X,Y	US, A, 4,322,012, Published 30 March, 1982 (Conti)	1-10
X,Y,	US, A, 4,147,268, Published 03 April, 1979 (Patel et al)	1-10
<p>¹⁵ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search ¹⁹		Date of Mailing of this International Search Report ²⁰
03 April 1985		18 APR 1985
International Searching Authority ¹		Signature of Authorized Officer ²⁰
ISA/US		Allan N. Shoap <i>Allan N. Shoap</i>

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